CONTINUING MEDICAL EDUCATION

Decubitus Ulcers: Pathophysiology and Primary Prevention

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SUMMARY

Background: Pressure sores are a serious complication of multimorbidity and lack of mobility. Decubitus ulcers have become rarer among bed-ridden patients because of the conscientious use of pressure-reducing measures and increased mobilization. Nonetheless, not all decubitus ulcers can be considered preventable or potentially curable, because poor circulation makes some patients more susceptible to them, and because cognitive impairment can make prophylactic measures difficult to apply.

Methods: A systematic literature search was performed in 2004 and 2005 in the setting of a health technology assessment, and a selective literature search was performed in 2009 for papers on the prevention of decubitus ulcers.

Results: Elderly, multimorbid patients with the immobility syndrome are at high risk for the development of decubitus ulcers, as are paraplegic patients. The most beneficial way to prevent decubitus ulcers, and to treat them once they are present, is to avoid excessive pressure by encouraging movement. At the same time, the risk factors that promote the development of decubitus ulcers should be minimized as far as possible.

Conclusions: Malnutrition, poor circulation (hypoperfusion), and underlying diseases that impair mobility should be recognized if present and then treated, and accompanying manifestations, such as pain, should be treated symptomatically. Over the patient's further course, the feasibility, implementation, and efficacy of ulcer-preventing measures should be repeatedly re-assessed and documented, so that any necessary changes can be made. Risk factors for the development of decubitus ulcers should be assessed at the time of the physician's first contact with an immobile patient, or as soon as the patient's condition deteriorates; this is a prerequisite for timely prevention. Once the risks have been assessed, therapeutic measures should be undertaken on the basis of the patient's individual risk profile, with an emphasis on active encouragement of movement and passive relief of pressure through frequent changes of position.

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Pressure ulcers are a serious complication of multimorbidity and immobility. Decubitus ulcers are not always preventable or curable. Impaired perfusion, among other factors, increases the risk of decubitus ulcers, and cognitive disturbances can make prophylactic measures more difficult (e1–e3). The prevalence of high-grade decubitus ulcers (grades 3 and 4) is as high as 3%, and may reach 4% among elderly persons receiving nursing care in institutions. There has been no significant decline in the prevalence of decubitus ulcers over the last 10 years, as a study from Hamburg has shown (1).

Risk factors should be assessed at the first contact of an immobile patient with a health-care professional. The appropriate measures to be taken can then be determined on the basis of the patient's individual risk profile, with an emphasis on two cardinal principles: active promotion of movement and passive pressure reduction through frequent changes of position. Furthermore, malnutrition, impaired perfusion, and any underlying diseases that restrict mobility should be addressed with specific therapy, and accompanying symptoms, such as pain, should be treated symptomatically (e4). Over the course of the patient's treatment, the feasibility, implementation, and efficacy of therapeutic measures should be periodically reviewed and documented and any necessary corrections should be made.

Good communication among all caregivers—primary care physicians, other (specialist) physicians, nurses, and relatives providing care—is desirable, but often difficult to maintain. When patients with decubitus ulcers, or at risk of developing them, are transferred from one care area to another, they should be

Prevalence

The prevalence of high-grade decubitus ulcers (grades 3 and 4) is as high as 3%. It reaches 4% in elderly persons receiving nursing care in institutions.

TABLE 1

Grading of decubitus ulcers according to the ICD-10-GM (German modification of the ICD-10), 2010 version

ICD code	Classification	Description
L89.0	Grade 1	Pressure zone with redness that does not blanch with fingertip pressure, with skin still intact
L89.1	Grade 2	Decubitus ulcer (pressure sore) with skin erosion, blister, partial loss of the epidermis and/or dermis, or skin loss
L89.2	Grade 3	Decubitus ulcer (pressure sore) with loss of all skin layers and damage or necrosis of the subcutaneous tissue, which may extend down to the underlying fascia
L89.3	Grade 4	Decubitus ulcer (pressure sore) with necrosis of muscle, bone, or supportive structures such as tendons or joint capsules

accompanied by appropriate documentation of the prophylactic and therapeutic measures that they are receiving (2).

The treatment of decubitus ulcers is such a large topic in itself that this article will concentrate exclusively on prevention. An updated international guideline on this single topic was published jointly in late 2009 by two specialized panels from Europe and the USA (the European Pressure Ulcer Advisory Panel [EPUAP] and the National Pressure Ulcer Advisory Panel [NPUAP]) (4).

The learning goals of this article for the reader are

- gaining an improved understanding of the causes of decubitus ulcers and the mechanisms by which they develop,
- learning the risk factors and the types of patients that are at risk,
- becoming familiar with specific preventive measures, and
- being able to inform and advise patients and their families about decubitus ulcers.

This review is based on a systematic literature search performed in 2004 and 2005 in the context of a health technology assessment, supplemented by a selective search of the literature up to 2009 concerning the prevention of decubitus ulcers (3).

A health technology assessment (HTA) is defined as a systematic evaluation of medical aids, therapeutic substances, devices, or techniques, diagnostic processes, or organizational structures that is based on the relevant evidence-based medical, economic, legal, and ethical literature and is intended to serve as an aid to decision-making in health care policy (e5). In Germany, HTAs have played an increasingly important role in health care policy from the mid-1990s onward. The German Agency for Health Technology Assessment (*Deutsche Agentur für HTA*, DAHTA) was founded in 2000 as a component of the German Institute of Medical Documentation and Information (*Deutsches Institut für medizinische Dokumentation und Information*, DIMDI). The DAHTA manages an HTA information system and a program for the generation of HTA reports (http://www.dimdi.de/static/en/hta/index.htm). The current review is based in part on HTA Report Number dDAHTA004, "Dekubitusprophylaxe und -therapie; decubital prophylaxis and therapy," in which the conclusions of 22 medical guidelines of high methodological quality were evaluated, extracted, and synoptically summarized according to a standardized protocol *(eBox)* (3).

An interdisciplinary authorship committee extracted and processed the information. Unless otherwise stated, all recommendations are based on the current evidence-based international guideline of the EPUAP and NPUAP (4). Emphasis is laid on measures whose efficacy, safety, and feasibility of implementation have been scientifically demonstrated (evidence level A or B), rather than on measures that are controversial or supported merely by expert opinion (evidence level C).

Classification and differential diagnosis

Pressure sores (decubitus ulcers, and also ulcers resulting from the medical use of plaster casts) are coded under diseases of the skin and its appendages *(Table 1)*. This disease entity does not include "decubitus" (i.e., trophic) ulcers of the uterine cervix (N86). The term refers to a wound that develops in the upper layers of the skin as the result of sustained, externally applied pressure and then enlarges both radially and into the deeper tissue layers, unless specific measures are taken to counteract the process (5). Decubitus ulcers are usually accompanied by an inflammatory reaction, and often by local bacterial colonization or systemic infection. Exudation from large areas of damaged skin leads to fluid and protein loss. Since decubitus ulcers first arise in the upper layers of the skin, then extend outward and downward, their severity is classified according to the depth of extension *(Figure 1)*. Persistent

Classification

Decubitus ulcers are a disease of the skin and its supportive structures.

Definition

A decubitus ulcer is a wound that develops in the upper layers of the skin as the result of sustained, externally applied pressure and then enlarges both radially and into the deeper tissue layers.

hypoperfusion and pressure injury of the upper layers of the skin result in a circumscribed area of erythema and induration. This erythema does not blanch when the area is depressed with a fingertip or glass spatula *(Figure 2)*. The damage can be reversed by removing the excessive pressure that caused it, as long as there is no open wound. As soon as a grade 1 decubitus ulcer (L89.0) is found, pressure-reducing measures such as pressure-free positioning, frequent changes of position, and frequent inspections should be ordered and carried out.

If the appropriate management is not instituted, cells of the basal layer die and become detached, and the necrosis then progresses beyond the basal membrane into the deeper layers (grade 2 decubitus ulcer, L89.1). Inspection in this stage often reveals vesicles (blisters) or open skin areas that have come about through loss of the stratum corneum. The pain resembles that of a second-degree burn, yet its perception may be blunted by concomitant sensory disturbances or by analgesic medication. An open wound is now present, and the normal barrier function of the intact skin has been lost. Once the ulcer has penetrated further down and traversed the subcutaneous tissue, fat or muscle tissue is visible at the bottom of the wound. Ulcers of this degree of severity (grade 3 decubitus ulcer, L89.2) can come about in no more than a few days, yet require many weeks of conservative treatment to heal or, alternatively, surgical coverage (6). If bone is visible at the bottom of the ulcer, an accompanying osteomyelitis should be presumed, and thus a systemic infection, carrying the danger of further complications (grade 4 decubitus ulcer, L89.3).

Decubitus ulcers are assessed not just by their depth, but also by their localization and horizontal extent and by the state of the wound. Fistulae, wound pockets, and signs of inflammation should be sought for. Serial photographic documentation, with a ruler included for scale in all pictures, is recommended for evaluation of the temporal course (7). Two additional categories are in use in the USA for wounds that are difficult to assess: "suspected decubitus ulcer" (not illustrated) for unclassifiable erythema, induration, or in dark skin types, and "decubitus ulcer of unknown depth" (not illustrated, corresponds to L89.9). The latter category was introduced as an aid to documentation, e.g., before necrotic areas have been surgically removed, because a reliable judgment of the depth of the ulcer may only be possible afterward. Decubitus ulcers in either of these two

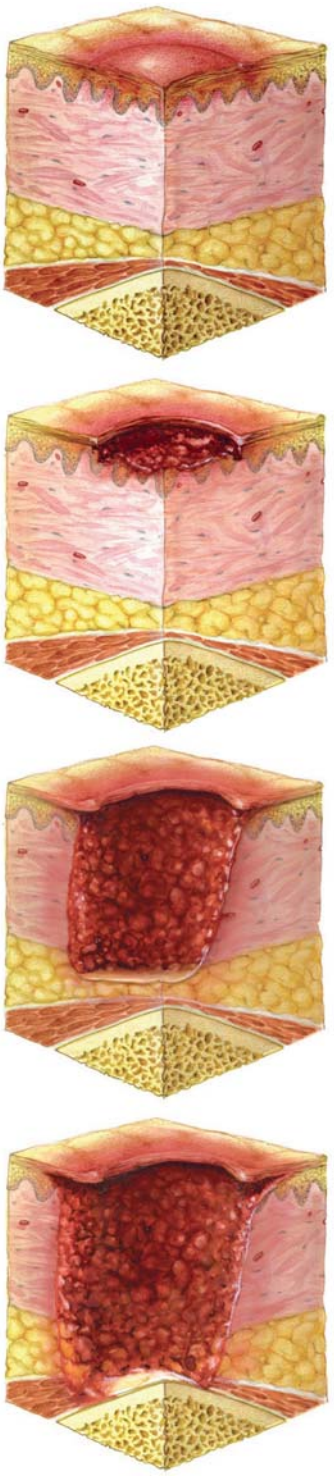


Figure 1:
A grading scale for decubitus ulcers of increasing severity: the designation of grades 1 through 4 is based on the depth of ulceration and the structures that are affected (reprinted with the kind permission of the National Pressure Ulcer Advisory Panel, NPUAP)

Further classification

Decubitus ulcers are classified by the depth of ulceration and by their site, extent, and wound condition.

Differential diagnosis

- Non-palpable erythema that blanches on compression, of other causes
- Chronic wounds of other types (diabetic ulcer, venous ulcer)
- Atypical site for decubitus ulcer

Figure 2:
A grade 2 decubitus ulcer with erythema that does not blanch with finger pressure, induration, and incipient blistering (reprinted with the kind permission of Dr. M. Michaelis, Albertinen-Haus, Hamburg).

categories must be treated with the immediate institution of all preventive and therapeutic measures used for definitively diagnosed decubitus ulcers (5).

The differential diagnosis of decubitus ulcers includes other causes of non-palpable erythema that blanches on compression, as well as chronic wounds of other types (diabetic ulcer, venous ulcer) at sites that are atypical for the formation of decubitus ulcers, such as the extensor surfaces of the limbs, the dorsum of the foot, or the fingertips (8).

Pathogenesis and risk factors

If a patient cannot move for a protracted length of time because of immobilizing medical conditions, paralysis, general anesthesia, or physical restraints, the externally applied pressure on prominent body surfaces may exceed the capillary pressure within the tissue, with ensuing interruption of circulation, hypoxic tissue damage, and, finally, necrosis. The critical duration of ischemia that can cause pressure injury varies greatly among individuals; as a rule of thumb, it lies somewhere between 30 and 240 minutes (e6). Aside from the externally applied pressure, the individually variable tolerance of tissue to ischemia also plays a very important role. Case-control studies have shown that patients with peripheral arterial occlusive disease are at higher risk not just of developing decubitus ulcers, but also of having an unfavorable course with poor wound healing (2); the reason is presumed to be that such patients have a delayed reperfusion time after the inciting external pressure has been removed. These processes are most strongly at work where bony or cartilaginous prominences have only a thin soft-tissue covering. Thus, the sites of predilection for decubitus ulcers are the cutaneous surfaces over the coccyx, spinous processes, heels, ankles, and elbows, and—for patients lying on their side—the iliac crest, the trochanters, and, less commonly, the helix of the ear. Cachectic patients are at greatest risk (1).

The most important cause of pressure ulcers is pressure exerted for an excessive period of time.

Other physical influences that can damage the skin include friction at the skin surface, shearing forces (i.e., lateral displacement of the skin, whose layers are of differing firmness), and moisture. Moisture does not cause a pressure injury per se, but it can promote the generation of chronic wounds by softening the upper layers of the skin (maceration) and changing the cutaneous chemical environment (altered pH). Incontinence and decubitus ulcers tend to affect the same groups of patients at risk, but a causal connection between the two has not been demonstrated to date (9).

Immobility is the main risk factor for decubitus ulcers because of their pathophysiology. All persons whose ability to move unaided is so greatly reduced that they can no longer regularly take pressure off vulnerable areas of the body by shifting their weight or changing their position are at risk of developing decubitus ulcers. All diseases that restrict independent mobility elevate this risk. Risk factors can be classified as intrinsic (patient-related) or extrinsic (related to the patient's environment). Conditions that place patients at risk include not just motor disturbances in the narrow sense, but also all other conditions that impair mobility, such as contractures, impairments of consciousness or perception (reduced ability to cooperate), or diminished pain perception, as under general anesthesia. On the other hand, a preserved ability to make even small pressure-reducing movements is protective (10). Moreover, cardiovascular diseases (peripheral arterial occlusive disease, congestive heart failure) and nutritional problems of various kinds (cachexia, malnutrition, inadequate fluid replacement) can impair the supply of oxygen and nutrients to peripheral tissue (2, 11). Often, a decubitus ulcer is maintained by multiple concomitant medical problems, including some that are a consequence of the ulcer itself *(Figure 3)*. Finally, certain obsolete and harmful measures are still being used to prevent and treat decubitus ulcers, albeit less and less commonly *(Box)*.

Primary risk factors

- Unchanging position, or too infrequent changes of position
- The externally applied pressure exceeds the capillary pressure in the tissue layers underneath
- Variable intolerance of tissue to ischemia
- Peripheral arterial occlusive disease

Causes

The most important cause of decubitus ulcers is externally applied pressure for an excessive period of time. Further damaging factors include friction at the skin surface, shearing forces, and moisture.

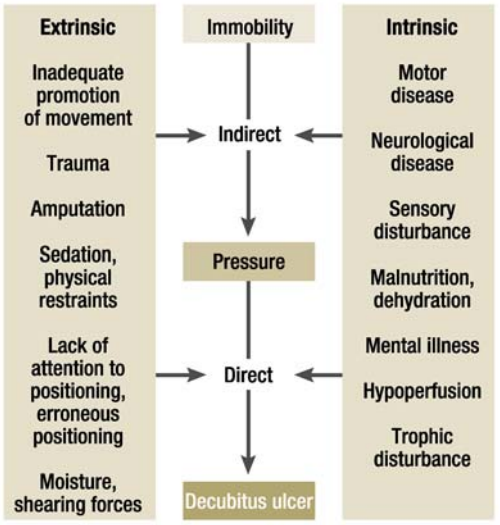
Epidemiology

There are no precise figures on the prevalence of decubitus ulcers, only estimates that vary from one place to another and depending on the manner of estimation. A group of experts estimated an overall prevalence of 9.2% among institutionalized patients, based on estimated local prevalences of

- 5% to 10% in hospitals,
- about 30% in geriatric clinics and homes for the elderly,
- and about 20% in nursing-dependent patients being cared for at home (3, 12).

These figures, combined with the estimate of the German Federal Statistical Office that about 2.3 million persons in Germany required chronic nursing care in 2007, yield a total of approximately 550 000 persons in Germany who have decubitus ulcers or are, at least, at high risk of developing one (e7). On the other hand, a more recent cross-sectional study from Berlin yielded lower figures than these, with a prevalence of 7.3% in nursing homes and 12.7% in hospitals (e8). An increasingly used technique for reducing data heterogeneity is to express prevalences as a percentage of affected persons within particular risk groups. Thus, Dutch and German nursing institutions were compared with respect to the prevalence of decubitus ulcers of grades 2, 3, or 4 among persons in a defined high-risk group, namely, patients with a score of 20 points or less on the Braden scale: The resulting figures were 13.4% in the Netherlands and 5.7% in Germany. Epidemiological studies generally do not include data on grade 1 decubitus ulcers, because decubitus ulcers are often not diagnosed when they are still in grade 1 (e8). In Hamburg, the continuous post-mortem documentation of severe (grades 3 and 4) decubitus ulcers through legally mandated autopsies of bodies that are to be cremated has enabled documentation of local prevalence trends: Decubitus ulcers became slightly less common in the late 1990s after the introduction of various quality-promoting measures, but a mildly increased prevalence, of unknown cause, has been observed in recent years (1). In 1998, the Institute of Forensic Medicine (*Institut für Rechtsmedizin*) studied the prevalence of decubitus ulcers prospectively in a cross-sectional study involving 10 222 autopsies: the overall prevalence was 11.2% (grades 1 to 4), with individual prevalences for each grade of 6.1% (grade 1), 3% (grade 2), 1.1% (grade 3), and 0.9% (grade 4) (e9).

FIGURE 3



The pathophysiology of decubitus ulcers: pressure damage and aggravating factors. The generation of a pressure sore: local ischemic damage because of externally applied pressure and concomitant risk factors

Risk groups

Patients at high risk for decubitus ulcers include those who are immobilized by severe illness or who have multiple risk factors for the condition, primarily elderly, multimorbid patients with functional limitations. The elderly account for more than 60% of decubitus patients and are thus the largest group among them, both because the elderly are more likely to suffer from immobilizing diseases such as stroke (3) and because age-related changes in the skin, blood vessels, and other organs give elderly patients a lesser functional reserve in the face of illness than younger patients with the same diseases (12). Thus, involuntary position changes during sleep are far less frequent in the elderly (even when healthy) than in younger persons. Multimorbid elderly patients are also more likely to suffer complications such as malnutrition or delirium. Geriatric assessment is an important means not just of identifying patients at risk, but also of comprehensive determining of the health problems and physiological reserves of multimorbid elderly patients, so that a coordinated treatment and nursing plan can be developed (13).

Risk assessment

Among the 2.3 million persons dependent on nursing care in Germany in 2007, 550 000 were considered to be at high risk for decubitus ulcers.

Elderly patients

Elderly patients constitute the single largest group (more than 60%) among all patients with decubitus ulcers.

BOX

Measures that are harmful, and therefore obsolete[*1]

- Sitting for hours at a time without pressure-reducing breaks in between (evidence level B)[*2]
  - Caution: high pressure on sacrum and coccyx
  - Caution: wheelchairs are mobility aids, not chairs for prolonged sitting
- Placing water or air cushions under the patient (evidence level C)
  - Caution: this does not reduce pressure!
- Application of topical medication to damaged skin (evidence level C)
  - Caution: impaired wound healing; antibiotics may provoke allergies and/or resistance
- Physical stimuli (brushing, massaging, cooling or heating with thermal appliances, blow-drying) (evidence level B)
  - Caution: degrades the cutaneous barrier and impairs wound healing

[*1]From (3) and (4)
[*2]Evidence-based recommendation grades are given according to the scheme of the Oxford Centre of Evidence-Based Medicine: Level A, good evidence; Level B, adequate evidence; Level C, small amount of evidence

Patients with spinal cord injury are a further higher risk group for decubitus ulcers. Fur such patients, regular en-bloc turning of the body every two to three hours is recommended, initially under medical observation in an intensive care unit, and in a specialized center, if possible (14). Likewise, patients undergoing intensive care because of severe illness, multiple trauma, or burns are at high risk. Among patients in all of these groups, the initial therapeutic emphasis is placed on the securing of vital functions and avoidance of worsening paralysis, with the prevention of decubitus ulcers being a secondary goal of treatment, where appropriate. Later on in these patients' course, the avoidance of pressure sores due to protracted sitting often becomes an important matter, as mobility aids such as wheelchairs are often not very well suited to pressure reduction (15). For patients in the final, preterminal phase of life, prophylactic measures will sometimes be discontinued, if the patient so desires (e9).

Preterm infants, whose protective reflexes and independent mobility are not yet well developed, are a further, entirely different risk group. The positioning of premature babies requires techniques that favor their ability to breathe freely, prevent sores as well as loss of heat, while at the same time mimicking the comfortable restriction of movement and associated sensory impulses that the still-unborn child experienced in the womb (for example, "nest positioning") (16).

Risk situations

Small pressure sores can be caused by foreign bodies of all types next to the patient's body, including blood-pressure cuffs, catheters, canulae, and movement-restricting dressings. Thus, all such objects should be placed in such a way that they contact the patient as little as possible and are not under tension. Limbs in movement-restricting dressings should be rechecked for hypoperfusion and sensorimotor complications no later than 24 hours after the dressing is applied, or earlier if the patient complains of pain, paresthesia, or swelling; dressings should be redone, if necessary, according to the PMS scheme (clinical examination of pulse, motor function, and sensory function). Orthoses should be used sparingly in patients with paralysis, as they also have impaired sensory function and may not feel the pain normally associated with pressure injuries. If an orthosis is used, frequent checking or limited wearing times should be part of the plan. Specially trained personnel are responsible for the positioning of patients with impaired consciousness in intensive care units and patients undergoing general anesthesia for surgery. If an operation requires more time than initially planned, the surgeon may need to reposition the patient intraoperatively after due consideration of the benefits and risks, and should document having done so. Patients should be informed preoperatively about the risk of pressure injuries (17).

A much more common phenomenon, and one that has attracted too little attention from trained caregivers and others, is the occurrence of pressure sores on the sacrum and coccyx after hour-long sitting on regular chairs, armchairs, or wheelchairs or sitting propped up in bed. Gel and foam cushions do not redistribute the pressure to any great extent, and thus regular pressure-reducing breaks are a necessary component of the individual nursing plan (3). Paraplegic and quadriplegic patients undergoing rehabilitation are trained how to shift their weight while sitting (14).

Profoundly dependent patients who are cared for exclusively by laypeople are at especially high risk.

Special risk factors and causative factors in the elderly

- Immobilizing diseases (stroke)
- Age-related changes in the skin, blood vessels, and other organs

Obsolete measures

- Sitting for hours at a time without pressure-reducing breaks in between
- Placing water or air cushions under the patient
- Application of topical medication to damaged skin
- Physical stimuli (brushing, massaging)

Supportive information, training, and counseling, e.g., in courses for caring laypeople that are organized by health insurance companies, as well as assistance from local governmental agencies and medical house calls including skin inspections, can all be beneficial—not just for the protection of these patients' health, but also to spare their caring relatives from excessive physical and emotional stress (18).

Risk assessment

The prevention of decubitus ulcers begins at the first patient contact. The patient (or a caregiver) is asked about any previous decubitus ulcers (risk of recurrence), the skin is inspected for any visible lesions or erythema, and the patient's degree of mobility is assessed. The individual risk of developing a decubitus ulcer is primarily determined, not by the particular diagnosis that the patient carries, but by his or her state of consciousness, mobility, and independence in caring for himself or herself and by the possible presence of ulcer-promoting risk factors. Many different instruments have been developed in order to support this multidimensional assessment with standardized documentation. In German hospitals, the Norton scale and (in intensive care units) the Waterlow scale are in wide use *(Table 2)*. The Braden scale is recommended for the assessment of elderly patients, because it takes account of a greater number of risk factors in gradated fashion. One important benefit of all these instruments is that they sensitize patients and caregivers to the problem of decubitus ulcers. A common feature is that all of them are intended for orientation only and cannot replace the professional assessment of a physician or an experienced nurse (19).

The Braden scale concentrates on the duration and intensity of external pressure (sensory function, activity, mobility) as well as the tolerance of the skin to potentially injurious factors (moistness, nutritional state, friction, shearing forces). The Norton scale documents patient-related risk factors for decubitus ulcers, such as advanced age, poor ability to cooperate / impaired mental state, skin condition, additional illnesses, and general medical condition, as well as mobility and incontinence. The Waterlow scale addresses both patient-related risk factors (body habitus and weight in relation to height, appetite, skin type, sex, age, continence, mobility, neurological deficits) and certain iatrogenic risk factors (major surgery, acute illness, medication) (19, 21).

TABLE 2

Overview of screening instruments that are commonly used in Germany[*1]

Type of risk factor	Braden scale	Norton scale (extended)	Waterlow scale
Age	–	X	X
General condition	–	X	X
Underlying illnesses	–	X	X
Sensation	X	–	–
Activity	X	X	–
Mobility	X	X	X
Skin condition	X	–	–
Continence	X	X	X
Nutrition, appetite	X	(X)	X
Cooperation	–	X	–
Iatrogenic risks	–	–	X
Friction, shearing forces	X	–	–
Medications	–	–	X

[*1] modified from (19)

For patients that belong to a high-risk group for decubitus ulcers or whose general condition has markedly deteriorated, risk assessment is supplemented by monitoring. After a positioning interval of about two hours (at first), the skin should be examined for erythema and induration (20).

Prevention and risk management

The major elements of decubitus ulcer prevention are the promotion of movement, pressure avoidance (type of positioning), pressure removal (positioning interval), and pressure distribution (positioning aids). These measures should be coordinated and frequently rechecked according to an individually developed prevention plan *(Table 3)*. Movement-promoting measures improve impaired mobility and help prevent further complications, such as contractures; such measures range from activating nursing care to complex interdisciplinary treatment and rehabilitation. Alternating positions are a means of pressure reduction and should be applied on an individual basis, e.g., supine positioning

Risk assessment

Standardized documentation aids in multidimensional risk assessment. The Norton Scale and the Waterlow Scale exist for this purpose. The Braden Scale is particularly suitable for risk assessment in elderly patients.

Risk management

Important preventive measures against decubitus ulcers include the promotion of movement, pressure avoidance by suitable positioning, pressure reduction (positioning interval), and pressure distribution (positioning aids).

TABLE 3

The theory and practice of decubitus ulcer prevention[*1]

Preventive principle	Strategies	Preventive measures	Implementation of preventive measures
Risk minimization	Risk identification	Identification of high-risk groups (C)[*2] Regular skin inspections (B)	Assessment by trained individual (skin inspection, mobility status, age) Risk scales
	Risk assessment	Identification of risk factors (C)	History, physical findings, skin inspection Geriatric assessment, including treatment plan
	Error avoidance	Patient identification (C) Documentation (C) Communication (C) Coordinated action (C) Team training (B)	Labeling Patient positioning plan Communication of plan to nursing staff Team discussion Instruction on procedures
Pressure reduction	Change of position	Individual patient positioning plan (C)	Frequency to be determined on the basis of skin inspections
	Types of positioning	Repositioning (A) Soft positioning (A) Positioning with no pressure on the heels (B) Team training (C)	30° oblique position Supine position 135° position Micropositioning Sitting position with extended knees V position Nest position Use of air cushions
	Reduction of pressure on bony prominences	Avoid direct bone-on-bone contact (C)	Shifted positioning Micropositioning Cushioning
	Distribution of pressure	Positioning systems (A) Individualized mattress selection (A)	Super-soft mattress (support pressure ca. 25 mm Hg) or microstimulation systems; For very high-risk patients or as treatment (caution: lowers patient's perception): varying-pressure systems; Airbed (low-flow); Only for paraplegic/quadriplegic patients: rotating bed, sandwich bed
Avoidance of skin damage	Avoidance of friction and shearing forces	Positioning technique (C)	Atraumatic positioning, positioning by two nurses, natural sheepskin
		Transfer technique (C) Ambulation aids (C)	Atraumatic transfer, natural sheepskin, en-bloc rotation, transfer by two nurses, rotating chair, ergotherapy
Avoidance of maceration	Skin protection	Avoidance of dampness and heat accumulation (C)	Skin protection patches or sprays (acrylate terpolymers, dilute hydrocolloids), regular change of incontinence aids
	Reinforcement of cutaneous barriers	Skin care (B)	Use of eudermic synthetic detergents, skin care (cream), nutrition
Promotion of movement	Passive movement	Positioning (A) Contracture prophylaxis (A) Sensory stimuli (C)	Movement of limbs and joints, basal stimulation
	Active movement	Initiation of movement (A) Practice of movement (A)	Physiotherapy, training to overcome deficits
Nutrition	Fluids	Fluid intake (C)	Drinking plan, parenteral infusion
	Solid food	Food intake for all patients at risk of decubitus ulcer (C) Food intake for patients at high risk of malnutrition, multimorbid patients, or post-surgical patients (A)	Enriched full diet (high-calorie, high-protein), preparation of special food as needed (e.g., dysphagia diet), food enrichment, parenteral nutrition

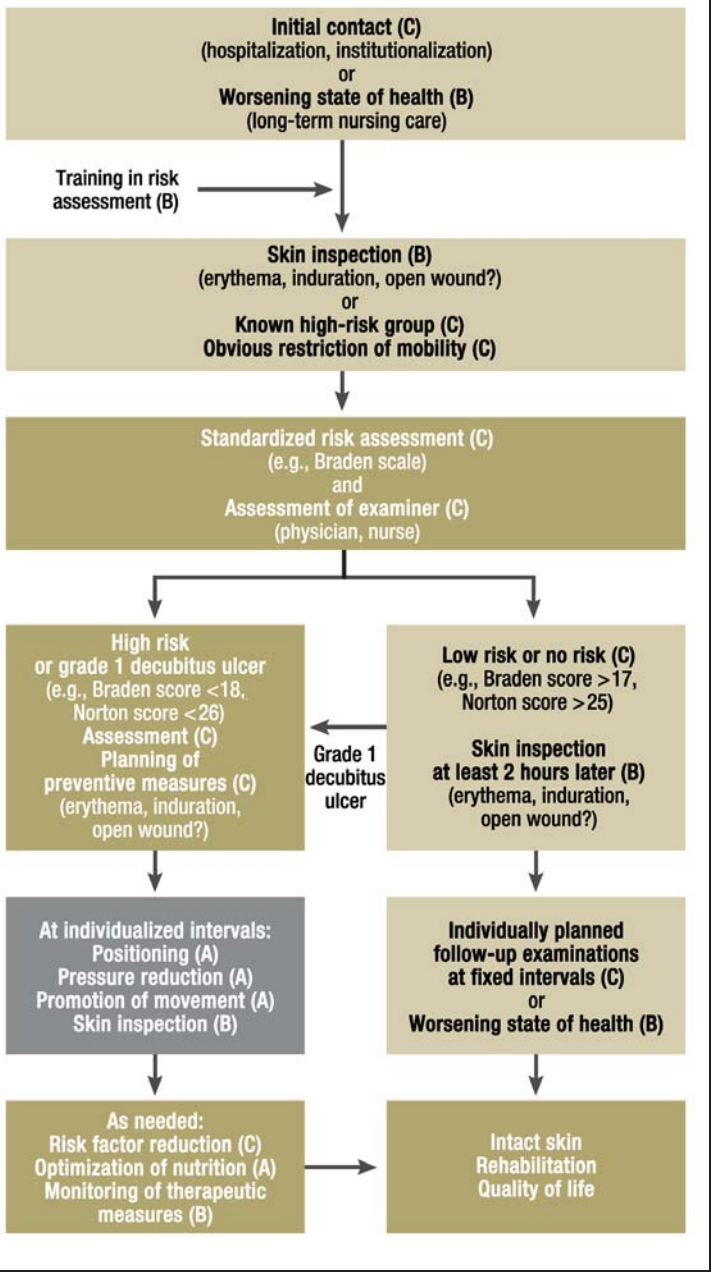
[*1] Modified from (3) and (4). [2] Evidence-based recommendation grades are given according to the scheme of the Oxford Centre of Evidence-Based Medicine: Level A, good evidence; Level B, adequate evidence; Level C, small amount of evidence

combined with 30° and 135° oblique positioning on alternating sides; limbs and pressure points should be kept free of pressure. Particular attention should be paid to instruction and involvement of the patient and his or her family, so that they, too, can take action to minimize the risk of decubitus ulcers (18, 21).

A meta-analysis (Cochrane Database, 2009) arrived at the conclusion that pressure-distributing positioning aids, such as super-soft foam mattresses (support pressure >25 mm Hg, regardless of type and manufacturer), are superior to traditional foam mattresses in that they significantly lower the incidence of decubitus sores (relative risk 0.34), yet they do not alone suffice to prevent pressure sores in the absence of regular repositioning and movement-promoting measures (22). The advantages and disadvantages of more technically sophisticated systems such as alternating-pressure mattresses or air-cushion beds are a topic of debate. These systems may facilitate the positioning of patients with multiple decubitus ulcers or massive obesity, yet they may also worsen motor function and the patient's perception of him- or herself in space. The best system to use is the one that allows alternating reduction of pressure while promoting movement as much as possible. Newer positioning systems that are said to promote "micro-movement" have not received adequate scientific study to date. Water- or sand-filled cushions are not suitable for pressure reduction. Gentle positioning and sheepskins (but not artificial sheepskins) have been found to be useful for the reduction of shearing forces. Many small studies of limited scientific value have been performed on cushion systems made by diverse manufacturers; the only recommendations that can be made are those that have been validated by scientific studies or confirmed by meta-analyses (22, e10).

Risk factors promoting the development of decubitus ulcers should be reduced as far as possible (e11). Older patients, for example, who are at risk of malnutrition (i.e., deficient or erroneous nutrition, not necessarily quantitatively inadequate nutrition) or already suffer from it, have been found to respond to a high-calorie, high-protein diet and adequate hydration with better wound healing, shorter hospital stays, and fewer complications such as infection or functional deterioration than a control group (4). It is recommended that such measures be instituted early to improve the overall prognosis (survival, independence status), even though not all prospective studies that specifically address the

FIGURE 4



Decision flowchart for individualized planning of decubitus ulcer prevention (modified from Armstrong et al. 2008). Evidence-based recommendation grades are given according to the scheme of the Oxford Centre of Evidence-Based Medicine: Level A, good evidence; Level B, adequate evidence; Level C, small amount of evidence.

Nutritional status

Elderly patients who are malnourished or at risk of malnutrition have better wound healing and stay in the hospital for a shorter period of time if they are given a high-calorie, protein-rich diet as well as plentiful fluids.

Positioning

The positioning system that is best for the individual patient is the one that permits pressure reduction through frequent changes of position and also promotes movement to the greatest possible extent.

risk of decubitus ulcers have shown a clear advantage (e12). Further practical recommendations can be found in the guideline on enteral nutrition of the DGEM (*Deutsche Gesellschaft für Ernährungsmedizin*, German Society of Nutritional Medicine) and DGG (*Deutsche Gesellschaft für Geriatrie*, German Geriatrics Society) (e13). Pain should be noted and adequately treated, as the advantages for the patient (better quality of life, improved mobility) outweigh the disadvantages (diminished perception). Frequent repositioning and skin inspections remain indispensable. For patients in the final, preterminal phase of life, individual desires may take precedence over the prevention of decubitus ulcers. Decisions with major consequences such as these should be explicitly justified (perhaps by a clinical ethics committee) and documented (3). The working methods, personnel, and equipment that are needed for the successful implementation of preventive measures should be clearly identified, e.g., in procedural training sessions *(Figure 4)*. The instruction and continued training of the responsible staff and the practical implementation that they carry out should be regularly monitored, so that improvements can be made if necessary and all participants can be repeatedly sensitized (23).

Additional remarks on the treatment of decubitus ulcers

Continuous, multidimensional risk minimization, as well as sustained efforts to reduce pressure and promote movement are essential components not just of decubitus ulcer prevention (the main topic of this review), but also of the treatment of decubitus ulcers once they have appeared. Further therapeutic measures include local wound treatment with hydroactive, atraumatic compresses and, in some cases, plastic surgical procedures (24). Surgery is appropriate only for patients who are not too ill to undergo it, whose prognosis is favorable enough to justify it, and whose wounds require it after optimal noninvasive treatment (e14). Infection and sepsis, if they occur, are life-threatening complications whose appropriate management is systemic antibiotic therapy after blood-drawing for culture, accompanied by whatever further measures are necessary (e.g., cardiovascular support, antipyretic treatment, and surgical elimination of the focus of infection). Vacuum pumps are used only in special cases; their use requires special experience (e15, e16)

Treatment

The same measures that are used to prevent pressure sores, i.e., pressure reduction and movement promotion, are also the essential components of treatment for pressure sores once they have arisen.

Overview

Decubitus ulcers are a complication of illness that causes suffering, increases morbidity, and leads to serious further complications (3). They can arise in a few hours or days but may take weeks or months to heal, depending on their severity and the accompanying circumstances; their proper treatment requires considerable resources, in terms of both money and staff (24). These are all reasons why it is important that prophylactic measures should always be initiated and implemented. Even when this is done, however, pressure sores cannot always be prevented in severely ill patients or those with multiple illnesses, and their treatment is often difficult (2, e1–e3). The proper care of decubitus ulcers requires the implementation of adequate preventive and therapeutic measures, and the documentation of these measures in both the medical and the nursing charts is important not just for medicolegal reasons (25). The purpose of risk assessment and risk minimization through pressure reduction, movement promotion, and the treatment of underlying illnesses is to lower the incidence of decubitus ulcers. The timely initiation and continued implementation of these measures in a coordinated risk management strategy, and the training of all of the involved health care professionals, are very important matters (4, 20, 23).

Conflict of interest statement
The authors declare that they have no conflict of interest as defined by the guidelines of the International Committee of Medical Journal Editors.

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Please answer the following questions to participate in our certified Continuing Medical Education program. Only one answer is possible per question. Please select the answer that is most appropriate.

Question 1

When a decubitus ulcer has visible blisters—i.e., necrosis has penetrated beyond the basal membrane into deeper layers of the skin—what stage of ulceration is present, according to the NPUAP classification?

a) NPUAP stage 1
b) NPUAP stage 2
c) NPUAP stage 3
d) NPUAP stage 4
e) NPUAP stage 5

Question 2

Which of the following is the fundamental prerequisite for the development of a decubitus ulcer during a critical period?

a) Poorly controlled diabetes mellitus
b) Peripheral arterial occlusive disease of grade II or higher
c) A traumatic, infectious, or inflammatory cutaneous lesion on a limb
d) Externally applied pressure exceeding the capillary pressure in the tissue
e) Postoperative stress incontinence in the aftermath of radical prostatectomy

Question 3

Which of the following conditions or underlying diseases implies an elevated risk of decubitus ulcers?

a) Rheumatoid arthritis
b) Diabetes mellitus
c) Congestive heart failure
d) Dementia
e) Immobility

Question 4

What is the critical temporal interval for ischemia as a cause of decubitus ulcers?

a) 5–15 minutes
b) 30–240 minutes
c) 6 hours
d) 24 hours
e) 2–3 days

Question 5

What scale is particularly suitable for the assessment of the risk of decubitus ulcers in elderly, multimorbid individuals?

a) The Waterlow Scale
b) The Braden Scale
c) The NPUAP Scale
d) The New York Scale
e) The Visual Analog Scale

Question 6

What is the main method of prevention of decubitus ulcers?

a) Rubbing the skin with alcohol
b) Lipid-rich creams
c) Massage
d) Pressure reduction
e) Warmth

Question 7

What is the main method of treatment for decubitus ulcers?

a) Cold application
b) Sterile dressings
c) Antibiotics
d) Analgesic drugs
e) Pressure reduction

Question 8

Who bears responsibility for preventing and treating decubitus ulcers?

a) The physician
b) The patient's family
c) The nurses
d) The insurance company
e) The physical therapist

Question 9

What is a suitable position for the prevention of decubitus ulcers in a bedridden patient?

a) The Trendelenburg position
b) The 90° lateral position
c) The 30° oblique position, with alternation
d) The supine position, on a rubber ring
e) The Jackson position

Question 10

A bedridden woman has been cared for at home for a long time. Your examination now reveals a gaping wound below the sacrum, with visible bone at the bottom of the wound. Which of the following additional diagnoses is likely to apply?

a) Osteomyelofibrosis and psoriasis
b) Osteomalacia and neurodermatitis
c) Osteomyelitis and systemic infection
d) Osteoporosis and diabetes
e) Osteopenia and peripheral arterial occlusive disease

CONTINUING MEDICAL EDUCATION

Decubitus Ulcers: Pathophysiology and Primary Prevention

Jennifer Anders, Axel Heinemann, Carsten Leffmann,
Maja Leutenegger, Franz Pröfener, Wolfgang von Renteln-Kruse

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CONTINUING MEDICAL EDUCATION

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eBOX

Evidence-based guidelines that were incorporated in the 2005 HTA Report (3)

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